

Challenges of Sustaining the International Space Station through 2020 and Beyond: Reassessing Confidence Targets for System Availability

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The International Space Station (ISS) was originally designed to operate until 2015 with a plan for deorbiting the ISS in 2016. Currently, the international partnership has agreed to extend the operations until 2020 and discussions are underway to extend the life even further to 2028. Each partner is responsible for the sustaining engineering, sparing, and maintenance of their own segments. National Aeronautics and Space Administration's (NASA's) challenge is to purchase the needed number of spares to maintain the functional availability of the ISS systems necessary for the United States On-Orbit Segment's contribution. This presentation introduces an analytical approach to assessing uncertainty in ISS hardware necessary to extend the life of the vehicle. Some key areas for consideration are: establishing what confidence targets are required to ensure science can be continuously carried out on the ISS, defining what confidence targets are reasonable to ensure vehicle survivability, considering what is required to determine if the confidence targets are too high, and whether sufficient number of spares are purchased. The results of the analysis will provide a methodological basis for reassessing vehicle subsystem confidence targets.

This analysis compares the probability of existing spares exceeding the total expected unit demand of the Orbital Replacement Unit (ORU) in functional hierarchies approximating the vehicle subsystems. In cases where the functional hierarchies' availability does not meet subsystem confidence targets, the analysis will further identify which ORUs may require additional spares to extend the life of the ISS. The resulting probability is dependent upon hardware reliability estimates. However, the ISS hardware fleet carries considerable epistemic uncertainty which must be factored into the development and execution of sparing risk postures. In addition, it is also recognized that uncertainty in the assessment is due to disconnects between modeled functions and actual subsystem operations. Perhaps most importantly, it is acknowledged that conservative confidence targets per subsystem are currently accepted.

This presentation will also discuss how subsystem confidence targets may be relaxed based on calculating the level of uncertainty for each corresponding ORU function. The presentation will conclude with the various strengths and limitations for implementing the analytical approach in sustaining the ISS through end of life; 2020 and beyond.